University of Maryland
Department of Physics and Astronomy
College Park, Maryland

PROGRESS REPORT

NsG 695

RESEARCH IN THE SPACE SCIENCES

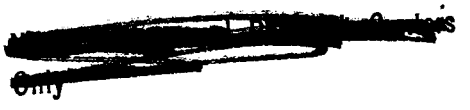
Period Covered:

June 10, 1965 - December 10, 1965

Submitted to:

National Aeronautics and Space Administration

February, 1966



The research supported by Grant NsG 695 is a joint cooperative research program involving the Department of Physics and Astronomy (DPA) and the Institute for Fluid Dynamics and Applied Mathematics (IFDAM) of the University of Maryland, and scientists of the Goddard Space Flight Center's Space Sciences Division.

The joint research programs during the period June 10, 1965 through December 10, 1965 were in the fields of plasma astrophysics research, solar spectroscopy, and space physics. The research is jointly supervised by Goddard and University personnel in their studies of such problems as the stability of interplanetary plasmas, the structure of collisionless shock waves, the identification of lines in the extreme solar ultraviolet, and the spectra of cosmic ray protons. The following specific research was done during the above period under this grant.

John Curtis, Supervised by Prof. G. Westerhout (DPA) and Dr. Musen (GSFC)

Mr. Curtis has been working on solving the problem of a lunar orbiter which includes the eccentricity of the earth's orbit.

Aharon Eviatar, Supervised by Prof. D.A. Tidman (IFDAM) and N. Ness (GSFC)

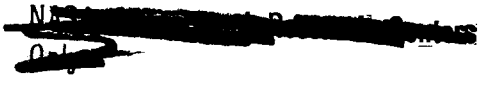
Research was performed on kinetic theory of plasmas with application to the interpretation of astrophysical and geophysical phenomena. The following papers were published:

1. Scattering of a Test Particle by Enhanced Plasma Fluctuations, with D.A. Tidman, Phys. Fluids, 8, 2059 (1965).
2. Scattering of Slow Electrons by Enhanced Ion-Waves Near the Geomagnetic Field Boundary, Bull. A.P.S. 11, 24 (1966).
3. The Role of Electrostatic Plasma Oscillations in Electron Scattering in the Earth's Outer Magnetosphere, Inst. of Fluid Dynamics Tech., Note BN-429, January, 1966, submitted to the Journal of Geophysical Research.

In these papers the transport of energetic particles in the regions around the earth due to wave-particle scattering effects is explored.

Lee Foster, Supervised by Prof. D.A. Tidman (IFDAM) and Dr. F. McDonald (GSFC)

Mr. Foster now has a working computer program for obtaining solutions of the Balescu-Lenard kinetic equation for an electron gas. It enables him to



study collective effects such as wave-particle scattering on the evolution of particle distribution functions. He intends to use it to study the shape of the high-velocity tail of photo-electrons in the distribution function for electrons in the ionosphere. The photo-electrons give rise to Cerenkov waves of electron plasma oscillations. These waves in turn make a contribution to electron scattering which may be of comparable importance to the usual two-particle scattering processes.

Rosalind Huang, Supervised by Dr. C. Fichtel (DPA) and Prof. D. Guss (DPA) and (GSFC)

The time was spent doing research with the Space Physics Group studying cosmic rays with nuclear emulsions.

James Kinsey, Supervised by Drs. F. McDonald and D. Hagge (GSFC)

The work accomplished to date under this grant has been in connection with the testing and calibration of semiconductor particle detectors for a low energy (1 - 200 MeV) cosmic ray package to be launched in a spacecraft late this year. Included in this work have been noise and stability measurements on surface barrier, lithium-drifted, and diffused junction type silicon detectors. Calibration so far has consisted of the measurement of window thicknesses, noise, and alpha particle peak widths using Am^{241} alpha particles (5.477 MeV). Just recently a proton beam using the $D^2(He^3, He^4)H^1$ reaction with the Goddard Van de Graaf accelerator giving energies of about 16 MeV has been used for calibration.

Paul McCormick, Supervised by Prof. U. Van Wijk (DPA) and Mr. N. MacAvoy (GSFC)

An atmospheric transmission experiment, using a laser beam, has been in the planning and design stage at GSFC for several months. Briefly, the system is composed of a 12-inch Cassegrain telescope, a He-Ne gas laser, a PMT and associated electronics. The laser beam, after passing through an arbitrary amount of atmosphere (say one mile), is reflected back to the telescope and heterodyned with a part of the beam that is sent directly to the PMT. The effects of the atmosphere (phase changes, etc.) are determined. The optical and mechanical parts of the system were constructed by Quanta Labs and were delivered

to Goddard about January 1, 1966. The equipment has been installed and alignment is now in progress.

Edwin McCullough, Supervised by Drs. F. McDonald and D.S. Evans (GSFC)

Work under this grant has allowed for the investigation of intrinsic properties of a low energy charged particle detector, the channel electron multiplier. Information about stability and absolute efficiency was sought in two independent experiments. As a result of the stability, experimental scientists at the GSFC have gained some measure of confidence for the use of this device on long satellite flights. The experiment designed and built for the absolute efficiency determination is at present being used to yield data with preliminary results being in agreement with some weak theoretical predictions.

Morris Pongratz, Supervised by Dr. F. McDonald (DPA) and (GSFC)

Mr. Pongratz plotted data from Explorer XIV on certain favorable days to attempt to determine if the outer boundary of the radiation belt fluctuated favorably with magnetic activity. This was followed by plotting low-energy proton intensities out to about 12 R_e to see if they varied with magnetic storms. He was attempting to see if the magnetic storms could possibly alter the earth's magnetic field enough to allow solar proton injection into the radiation belts. The proton intensity greatly affected the gain on the satellite leaving only one unobscured case during passes on February 11, 1963. On these passes there were significant proton intensities out to 12 R_e.

Guenter Riegler, Supervised by Dr. F. McDonald (DPA) and Dr. Boldt (GSFC)

Research was performed in connection with x-ray astronomy experiments. The feasibility of x-ray cameras was investigated and programs were set up for the computation of celestial coordinates from geographical coordinates and universal time. Most of the time was spent on the construction and completion of a specially adapted 16mm camera which takes pictures of the horizon from a balloon gondola on infrared film with exposure times cyclically varying in several steps from 1/44 to 20 seconds. This unit was successfully flown December 7, 1965 from New Mexico.

Barrett Ripin, Supervised by Drs. F. McDonald (DPA) and Konradi (GSFC)

Mr. Ripin aided Dr. Konradi with his studies of particle motion in the area surrounding the earth.

T. Scott Smith, Supervised by Prof. E.v.P. Smith (DPA) and Dr. Neupert (GSFC)

A computer program for investigating intercorrelations between the lines of the extreme ultraviolet solar spectrum was completed and yielded coefficients, slope deviations etc., for correlations between 56 lines. Averaged scans for six significant periods during the flight of the orbiting solar observatory were examined and relative enhancements were derived for 97 lines. A computer program for making Hartree-Fock calculations of atomic structure was used to investigate the wavelengths of transitions between various levels of the Fe XIV and Fe XV atoms. The structure of members of the isoelectronic sequences of these atoms were calculated to be able to evaluate the accuracy of the procedure. A summary and evaluation of the method was prepared. In essence, the calculations are not sufficiently accurate to form wavelength predictions.

Howard Stainer, Supervised by Prof. D.A. Tidman (IFDAM)

During the past six months he has been aiding Prof. Tidman in the construction of a theoretical model to explain the observed line splitting of Type II solar radio bursts. These bursts are believed to originate behind a collisionless shock front which is rising slowly through the solar corona. The work extends previous calculations based on enhanced plasma bremsstrahlung[1,2] to include the effects of a weak coronal magnetic field. Under the appropriate conditions we show that this magnetic field is capable of splitting the fundamental and first harmonic of the emitted radiation into sub-bands, thus explaining all the major features of these bursts. The magnitude of this splitting enables us to estimate the strength of the magnetic field in the corona. A paper is in progress and will be published as a technical note very shortly.

Dr. M. Haggerty

Work has continued on a project which was sponsored by the Advanced Research Projects Agency until August 31, 1965, Contract No. NONR 839(38) (Office of Naval Research), ARPS Order No. 529, at the Polytechnic Institute of Brooklyn. The project

1. Tidman and Dupree, Phys. Fluids, 8, No. 10, 1860 (1965).
2. Tidman, Planet, Space Sci., 13, 781 (1965).

is aimed at the establishment of a kinetic theory of diffusion of a plasma column across a constant uniform magnetic field, using the theory of Prigogine and Balescu. A preliminary research report dated August 10, 1965 was prepared (Report No. PIBMRI-1289-65, Polytechnic Institute of Brooklyn), and work has continued on the refinement and correction of the material in that report. The results will be reported at the American Physical Society New York meeting (Bull. Am. Phys. Soc. 11, 123 (1966)). They have been generalized so as to apply to a plasma with an anisotropic velocity distribution, providing collective effects are ignored. The treatment of such a general anisotropy including collective effects is still an unsolved problem.

Prof. A. Lenchek

Theoretical studies of the Van Allen radiation are in progress. Numerical calculations of the spatial distribution of albedo neutron decay are being made.

Dr. G. Skadron

Since joining the Department of Physics and Astronomy in September, 1965, Dr. Skadron's research has related to the problem of solar modulation of galactic cosmic rays. The intent of the work has been, first, to construct a model for the interplanetary electric and magnetic fields, and then to formulate how the cosmic rays move through phase space under the action of such fields. This attempt to describe the motion of cosmic rays through phase space has led to a study of the formal relationship between the Boltzmann equations, Fokker-Planck equation, one dimensional and three dimensional diffusion equations. The solar modulation calculation is currently still in its infancy. In addition, time has been spent preparing an article for publication in Reviews of Geophysics. The paper, "A Model for the Origin and Properties of the Cosmic Ray Rigidity Spectrum," is based upon work carried out for the Ph.D. degree at the University of Rochester. Finally, a part of the activity has been to maintain liaison with the experimental cosmic ray group at the GSFC.

The principal investigators on this grant have been Professors H. Laster, E.v.P. Smith, and D.A. Tidman. They have supervised the selection of assistants and shared in their research direction.